Innovation and change in organizational relationships: interdisciplinary contexts

Julie Thompson Klein

USWCP/CLL, Wayne State University, Detroit, Michigan 48202, USA.

Abstract

From July 13–15 of 1988 individuals from nine countries gathered at the Manchester Business School for the fifth international conference of INTERSTUDY (the International Association for the Study of Interdisciplinary Research). Entitled 'Interdisciplinary Research and the World Marketplace,' the conference was co-sponsored by the Manchester Business School and the journal R&D MANAGEMENT. Founded in 1980, Interstudy has endeavoured to advance the art and science of IDR (interdisciplinary problem-focussed research) by organizing international meetings for representatives of the academy, industry, and government. Its major accomplishment has been publication of the results of those meetings in four books. These books, along with other publications in the growing field of IDR, provide a valuable collection of resources for scholars, managers, researchers, and practitioners.

THE IDR CONTEXT

The scholarly investigation of IDR is a relatively recent phenomenon, a byproduct of growing involvement in mission-oriented research and widening study of relationships among science, technology, and society. A predominantly descriptive literature, it is rich in case studies, though it lacks extensive empirical work and has tended to emphasize academic settings in North America and Europe. The contributors to the literature are widely dispersed and usually consider IDR a subset of problems encountered in their original disciplines, which include most frequently management, engineering, an academic field of science or technology, institutional or policy research, and, to a much lesser extent, sociology of knowledge. They are joined, both randomly and periodically, by members of industry and government who are interested primarily in more effective management of problem-focussed research and product design. While a number of individuals have made IDR their speciality, the number is relatively small, and there is a tendency for individuals to move in and out of the field.

Correspondingly, IDR itself is dispersed across domains and is never singular in character. System engineering is a case in point. As Brian Mar (University of Washington) pointed out in a paper written for the Manchester conference, there is a strong community in the aerospace industry that has labelled a unique set of practices 'system engineering.' Yet, there is no consensus on a definition of system engineering and no professional organization for system engineers. Moreover, the job classification of system engineer varies from organization to organization, and, within universities, is an umbrella term for a variety of education programmes, varying from acquisition engineering to engineering design to system analysis and operations research.

The books that have emerged from INTERSTUDY conferences reflect this breadth and variety. The first two books provide an overview of IDR. The initial one, *Interdisciplinary Research Groups: Their Management and Organization*, stems from a 1979 conference in West Germany that was the catalyst for the organization. Edited by Richard T. Barth and Rudy Steck, and published by the International Research Group on Interdisciplinary Programs (1979), the book surveys issues surrounding the management, organizational structure, and group dynamics of IDR. The case studies represent a variety of areas, including the pharmaceutical and telecommunications industries, technology assessments, a Swedish ecosystem project, urban traffic systems, and several settings for research in U.S., British, and Polish universi-

ties. The second book, *Managing Interdisciplinary Research*, stems from a 1981 conference at the Manchester Business School. Edited by S. R. Epton, R. L. Payne, and A. W. Pearson, and published by John Wiley & Sons (1983), this volume features an introductory synthesis of the nomenclature, concepts, and organizational forms of IDR. The case studies represent projects on noise control, freshwater diversion, marine technology, and a variety of research activities being conducted in U.S. and British institutes. They also cross a range of fields, including the biomedical sciences, genetic engineering, and futures research. In addition, there are papers dealing with issues of peer review, performance, productivity, and leadership.

The third and fourth books are the result of two quite different attempts to direct the focus. The third, *Managing High Technology: An Interdisciplinary Perspective*, stems from a 1984 meeting in Seattle, Washington (U.S.). Edited by B. W. Mar, W. T. Newell, and B. O. Saxberg, and published by North Holland (1985), the book emphasizes IDR in high technology settings. Reflecting increased representation from industry, the case studies in this volume are drawn from such areas as pharmaceuticals, electronics, space engineering, computer systems, environmental assessment, technology forecasting, university engineering centres, U.S. governmental settings, and a variety of industrial R&D units. There is also a sustained focus on interface issues, directed at improving collaboration across not only academic disciplines but also functional activities in industry. In addition, there are papers on organizational forms and management strategies, as well as broader reflections on knowledge. The fourth book in the series, which was edited by P. H. Birnbaum, D. R. Baldwin, and F. A. Rossini, is forthcoming from Oxford University Press. Tentatively entitled *International Research Management: Studies in Interdisciplinary Methods*, this book is the result of a much smaller, more intensive workshop among selected individuals who met in 1986, in Minneapolis, Minnesota (U.S.). The group was asked to examine the lifecycle of IDR in greater depth: its (1) preconditions, (2) process, and (3) impacts. The case studies are drawn from Brazilian, Japanese, Israeli, and U.S. settings, and the book contains a sizable bibliography. Its appearance will be announced in both THE INTERSTUDY BULLETIN and R&D MANAGEMENT.

These four books demonstrate the role INTERSTUDY has played in helping to consolidate dialogue on IDR. Those who wish to explore the literature in greater depth will find two additional resources helpful. Both are published in the United States. The first is *Interdisciplinary Analysis and Research: A Book of Readings*, published by Lomond (Maryland) in 1986. Edited by D. Chubin, A. Porter, F. Rossini, and T. Connolly, this book is an anthology of reprints from the dispersed literature on interdisciplinary research, with emphasis on IDR. It also contains an annotated bibliography. The second is *Interdisciplinarity: History, Theory and Practice*, published by Wayne State University Press in 1989. Written by Julie Thompson Klein, the book is a comprehensive study of the concept of interdisciplinarity in research, education, and health care. It includes a synthesis of the scholarship on IDR and an extensive bibliography of the IDR and other interdisciplinary literatures.

THE CONTEMPORARY CONTEXT

Participants who gathered for the 1988 conference reflected on the growth of IDR within the university and on the academic/industrial interface. Like their predecessors they represented many contexts, including the British pharmaceutical industry, a French mobile satellite communication system, a Dutch firm for scientific services, the U.S. multidisciplinary engineering centres, a variety of U.S. centres and institutes, the British and U.S. systems of higher education, and the scientific research arm of NATO. In coming together they formed a collection of discrete voices reporting a common phenomenon, the increase of inter- and intra-organizational linkages. These linkages constitute institutionalized responses to changes taking place in contemporary science, technology, and society.

Innovations, as Israel Dror (RAFAEL, Israel) demonstrated in his analysis of patents in the industrial and technological realm, seldom rely on one discipline. Similarly,

noting a pull toward practical problems in the modern sciences, Craig Sinclair (NATO) emphasized that practical problems seldom define themselves neatly within traditional academic boundaries. Hence, the organization of research into interdisciplinary teams grouped around problem areas — materials, educational technology, ecoscience, large system design — is more common. The trend is also apparent in basic research — in the investigation of basic mechanisms of memory and in the study of mammalian evolution. Within industry, the move toward interdisciplinary and interorganizational linkages has been propelled by pressure for economic competitiveness and the need for greater resources, usually in the form of costly equipment and advanced technical knowledge. Simultaneously, universities have turned toward industry for research personnel and equipment, and to expedite the flow of technology from campus laboratories to the marketplace. As a result, Etzkowitz and Peters (Rensselaer Polytechnic Institute) observed, there is a degree of convergence going on between the university and industry: 'Universities are becoming more firm-like; firms are becoming more university-like in the specific sense that universities are becoming more involved in the sale of knowledge and firms in the sharing of knowledge.'

The linkages are of several kinds. They range from the flow of personnel across academic and industrial laboratories to contract research, entrepreneurial firms, patent and licensing operations, joint ventures and mergers, formal networks and consortia, research centres and institutes, offices of technology transfer, and science parks.

Many papers at the Manchester conference dealt with specific kinds of linkages, with an overall emphasis on examples in science, technology, and engineering. Etzkowitz and Peters discussed four major innovations in knowledge transfer: (1) interdisciplinary research centres, (2) offices of technology transfer, (3) science parks, (4) small firms. Frederick Rossini described a variety of programmes incorporated under the Office of Interdisciplinary Programs at Georgia Institute of Technology, and Paul Rigby reported on externally funded interdisciplinary research institutes at The Pennsylvania State University. Drawing upon data collected from thirty-one U.S. universities, including institutions with NSF-funded multidisciplinary engineering centres, Patricia Laughlin and Anne M. H. Sigerstad (Carnegie-Mellon University) surveyed major issues, incentives, and barriers to IDR. Bringing an international perspective to bear upon the subject, Craig Sinclair chronicled attempts to bridge science and industry as well as national boundaries through NATO research programmes.

Correspondingly, there is also increasing importance being attached to projects within organizations. These temporary groups, Jerry Dermer (York University) explained, may be labelled 'project,' 'working group,' '*ad hoc* committee,' 'venture,' 'task force,' or 'team.' Regardless of their title, though, they represent the same phenomenon and are, he added, the most complex of interdisciplinary groups to manage. Increasing use of interorganizational linkages and intraorganizational projects has profound implications for the management of research. To begin with, established patterns of organizational behaviour are not viable models for judging the work being conducted in these organizations, regardless of their size. Moreover, despite the obvious need for continuing collaborative relationships and strong economic incentives for their establishment, there remain a variety of financial, institutional, and cultural barriers that inhibit collaborative work. Finally, the complex nature of the problems being addressed creates a heightened ambiguity that is only exacerbated by sociopolitical dimensions of the problems. Operating with little or no precedent, applying old norms to new situations, the practitioners and their problems constitute an adhocracy.

PRACTICAL TOOLS

One of the important outcomes of the conference was the presentation of practical tools for managing IDR in both inter- and intra-organizational contexts. Brian Mar wrote about the top-down, iterative, problem-solving approach of system engineering. It is a process of identifying goals and objectives, along with their related resources and constraints. By identifying as many alternatives as possible, researchers and

managers can examine alternatives in order to rank them against each other, facilitating a synthesis that will lead to the discovery of new or better solutions. Reflecting a similar concern for process, Nicholas Danila (Institute of Management, Paris) presented a support graph that has proven particularly useful in the implementation stages. Already applied to more than 200 high technology projects, the support graph is an integrative tool that facilitates common language through the identification of a general objective, partial objectives, subobjectives, and the relationship between activities, objectives, and resources. Danila explained how support graphs may be constructed using a top-down, bottom-up, or interdisciplinary approach.

The most sustained presentation of models was the report by Ball *et al.* on a study of the R&D/marketing interface in three pharmaceutical companies. By adapting several existing models and frameworks they were able to identify problems which arise at the interface, depicting them in descriptive, graphical, and scoring fashion. A number of essential needs emerged, though greater regularity of communication, fuller appreciation of each other's needs, and extensive support from senior management were highest on the list. By using a time-based presentation of marketing and technical tasks, they were able to create a framework for considering relationships between functional areas and the individuals in those areas. They supported the framework with a simple scoring methodology which made it possible to determine key factors that influence attitudes and behaviour. Then they established guidelines for assessing the important characteristics of interface, accentuating the factors of status, communication, appreciation, and trust. Their use of the Gold and Gold[1] model for monitoring the interface was also highly productive because it allowed analysis of individual, interpersonal transactions within collaborations. Gold and Gold found three classifications of interactions: contracting, partnership, and consulting. Each is distinguishable by divisions of responsibility among the participants, from separation to sharing. The work that Ball, *et al.* have done demonstrates that graphical and weighting procedures have the potential to assist control of product development by facilitating a time-related assessment of technical and marketing activities.

There were, in addition, descriptive accounts based upon managerial experience. Sharing Danila's concern for stages in the lifecycle of IDR, George Pogany (International Scientific Services, Brussels) focussed on selection of the research portfolio, scale-up, and implementation. Pogany emphasized the importance of having not only managers who encourage cooperation across organizational barriers but also 'gatekeepers' who are willing and able to translate the different language of the parties involved in IDR. Sharing Pogany's concern for personnel, Keith Kilburn (Southampton) assessed the role of the three main kinds of protagonists in the technical world: the paymaster, the organizer, and the doer. Kilburn made this assessment with a keen eye towards strong and weak indicators of the need for IDR in an organization.

IMPLICATIONS

The changes that are taking place, Etzkowitz and Peters once remarked, are subtle but nevertheless real. They have several implications. Edward Howard (University of Denver) raised one of the major implications, that of improving education and training, in his paper on Management of Technology (MOT) programmes. MOT is a market-driven need being demanded by many high technology firms. This need was created by issues of global competitiveness, management of change, and management of large projects. A variety of MOT courses are appearing in U.S. universities, though it is most apparent in programmes such as engineering management and space studies. The significance of MOT extends well beyond individual academic programmes in the U.S., because it is a reflection of the widespread need for more appropriate training to deal with increasingly larger and more complex projects on both a national and a global scale.

[1] H. J. Gold and S. E. Gold (1985) Implementation of a model to improve productivity of interdisciplinary groups. In *Managing High Technology: an Interdisciplinary Perspective*, Eds. B. W. Mar, W. T. Newell and B. O. Saxberg, Amsterdam: North Holland. pp. 255–267.

Our ability to deal with the increased pressure for innovation and the changes that are taking place will clearly be enhanced by greater understanding of interorganizational relationships (IOR). David Dill (University of North Carolina, Chapel Hill) addressed this need by presenting four perspectives on the nature of interorganizational relationships devised to facilitate innovation: (1) population ecology, (2) resource dependence, (3) marketing, and (4) process. Dill concluded that current discussion of interinstitutional linkages and concern for preserving academic autonomy have obscured potentially significant structural changes that are occurring between and among universities and industries. This situation suggests the need for national-level policy analysis of the most fruitful linkages between universities and industries. Increasing economic competition in the international marketplace, he added, is likely to alter the view of R&D spending as a 'strategic lever,' raising new concerns about the relationship between R&D expenditure and innovation. Moreover, the entire issue of the university's relationship to government and industrial groups needs to be examined: in terms of the nature and location of technologically-oriented organizations in proximity to the university, and in terms of the most effective collaborative structures, types, and communication patterns.

There are, in addition, concerns arising from the continued narrowing of the gulf between basic and applied research and, concomitantly, the progressive alignment of the idea of interdisciplinarity with more purely instrumental and pragmatic objectives. Paul Rigby recalled the fears of Penn State faculty, who worried that seeking funding from the private sector might lead to an overemphasis on applied research. With the increased blurring of boundaries between basic and applied research, this fear is growing in universities. Paul Hoch (Warwick University) addressed the matter as well, in reviewing the proposal for University Research Centres (URCs) within the British educational system. Conceived as a way of concentrating and redeploying limited scientific resources both between and within institutions, the URCs are intended to foster research in areas of strategic economic importance. However, the proposal has raised concern over not only its potential for creating a trifurcation of the British university system, by maximizing research resources in certain institutions, but also the stipulation of visiting research teams of university scientists and the favouring of natural sciences over the human sciences. These concerns only underscore Dill's argument for national, indeed international, policy making in the face of limited resources.

In drawing their deliberations to a close, participants in the 1988 Manchester conference endorsed a change in strategy for future international meetings of INTERSTUDY. Rather than narrowing discussion by continuing to frame it in terms of disciplinarity and interdisciplinarity, a strategy that accentuates differences between academic and industrial sectors, those who study, conduct, and manage IDR need to examine collaboratively the problem-solving process itself. In addition, they need to bridge the gap that currently exists between generic models and strategic variables of performance. This will require paying greater attention to how research managers can and do organize projects to respond to problems that are highly variable in nature. Building centres for IDR does increase the possibility of unplanned creative problem solving, but researchers and managers also need to know concrete techniques for facilitating collaborative work in different institutional contexts and in the different stages of the project lifecycle. The agenda is large indeed.

LIST OF ORIGINAL PAPERS AND AUTHOR AFFILIATIONS

D. F. Ball (School of Economics and Accounting, Leicester Polytechnic)

C. G. Elstone, A. W. Pearson, & E. A. Philipps, R&D Research Unit, Manchester Business School, Booth Street West, Manchester M15 6PB (UNITED KINGDOM) "Developing Frameworks for Managing the R&D/Marketing Interface in the Pharmaceutical Industry"

Nicholas V. Danila, Professor and Consultant, Institute of Public Management, 17, rue Emile Dubois, 75014 – Paris (FRANCE) "Support Graph for the Management of High Technology Projects"

David D. Dill, Office of the Chancellor, University of North Carolina at Chapel Hill, CB #9100, 02 South Building, Chapel Hill, North Carolina 27599 (U.S.A.) "University/Industry Research Collaborations: An Analysis of Interorganizational Relationships"

Israel Dror, Chief Engineer and Director of Strategic Planning RAFAEL, (14) P.O. Box 2250, Haifa 31021 (ISRAEL) "Mapping Technology Interactions"

Jerry Dermer, Faculty of Administrative Studies, York University, North York, Ontario M3J 1P3 (CANADA) "Intraorganizational Interdisciplinary Projects: Design Issues"

Henry Etzkowitz, Department of Sociology, State University of New York at Purchase and Rensselaer Polytechnic Institute, Center for Science and Technology Policy

Lois Peters, School of Management, Rensselaer Polytechnic Institute, Lally Management Center, Troy, New York 12180-3590 (U.S.A.) "Organizational Innovation in the University for Knowledge Transfer"

Paul K. Hoch, Head of Science Policy and Innovation Research Unit, Warwick University, (UNITED KINGDOM) "The New British Interdisciplinary University Research Centres: Avenue of Expansion or Road to Retrenchment?"

Edward Howard, Professor and Chair, College of Systems Science, University of Denver, University Park, Denver, Colorado 80208 (U.S.A.) "The Management of Technology (MOT): A New Interdisciplinary Thrust in U.S. Universities"

K. D. Kilburn, Consultant, Southampton "Creating and Maintaining an Effective Inter-Disciplinary Research Team"

Julie Thompson Klein, Associate Professor of Humanities, USWCP/CLL, 6001 Cass Avenue, 4th Floor, Wayne State University, Detroit, Michigan 48202 (U.S.A.) "The Future of IDR"

Patricia Laughlin & Anne M. H. Sigerstad, Carnegie-Mellon University, 5000 Forbes Avenue, Pittsburgh, Pennsylvania 15213 (U.S.A.) "Encouraging Interdisciplinary Research: Issues, Incentives, and Barriers"

Brian W. Mar, Department of Civil Engineering, 307 More Hall, FX-10, University of Washington, Seattle, Washington 98195 "System Engineering: The Industrial Solution to the Management of Interdisciplinary Problem Solving"

George A. Pogany, President, International Scientific Services, Teniershaan 21, 1412 JE Naarden, The Netherlands "Interdisciplinary Management and Effective Industrial R&D"

Paul H. Rigby, Professor of Business Administration and Associate Dean for Research, College of Business Administration, The Pennsylvania State University, 108 Business Administration 11, University Park, Pennsylvania 16802 "Interdisciplinary Research as a Means for Securing Funding for Research"

Frederick A. Rossini, Office of Interdisciplinary Programs, Georgia Institute of Technology, Atlanta, Georgia 30032-0130 "The Office of Interdisciplinary Programs: An Innovative Approach to Institutionalizing Interdisciplinary Research in the University"

Craig Sinclair, Director, Advanced Research Workshop Programme, Scientific Affairs Division, DeL'otan, North Atlantic Treaty Organization, B-1110 Brussels (BELGIUM) "The Role of an International Funding Agency in Promoting Innovation" and "Supporting Interdisciplinary Science: Some International Experience"

CONFERENCE COORDINATORS:

Donald R. Baldwin, Assistant Provost for Research, The Graduate School, 201 Administration Bldg, AG-10 University of Washington, Seattle, Washington 98195 (U.S.A.)

Roy Payne, Professor of Organizational Behaviour, Manchester Business School, University of Manchester, Booth Street West, Manchester M15 6PB (UNITED KINGDOM)

Julie Thompson Klein

Frederick Rossini